# Discounting: Sustainability and Time-Inconsistency

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Economics of Human/Environment
Interactions, Lecture 4
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# What is discounting?

- Hackett: "The **discount rate** is the rate at which the present value of increasingly distant payments shrinks"
- Discounting implies a preference to consume more now and less in the future
- Evidence indicates that humans and non-humans make choices consistent with the concept of discounting

# What is “present discounted value”? (NPV) (Hackett)

If there is one payment to be made “T” years from the present, and if the discount rate is “r”, then the *PDV* of the single future payment is found as follows:

*PDV* of a single future payment = ($ payment, k years from the present)/$(1+r)^T$.

# PDV of a stream of payments …(Hackett)

If there is a regular stream of payments received each year "i" from the present, and if the discount rate is "r", then the *PDV* of the stream of payments is found as follows:

*PDV* of a stream of future payments =

$\Sigma_i$ ($ payment, i years from the present)/$(1+r)^i$, i = 0, 1, 2, ..., n.

# Is discounting consistent with sustainability?

- Discounting implies a choice of decreasing consumption/resource availability over time. What does this imply for the well-being of future generations?
- Market discount rates may be too high from a social perspective
- What does this imply about market economies and sustainability?

# Why discount?

- Opportunity cost of capital:
  - Current consumption
  - Alternative investment:  market rate of return
  - Hotelling's rule argues that markets will equate the two (see Hackett chapter 5)
- Result is that individuals require compensation at least as high as the next best investment alternative

# Hackett example of effect of discounting on env. Investment decisions

Example: Suppose that you own an older, poorly insulated home. Your company will move you in five years to another town. Realtors tell you that you cannot recoup investment in insulation in the sales price of the home.

# Hackett example 2

Suppose the insulation job costs $4,000 at time 0 (today), generates $1,000 in cost savings in each of the next five years. At what discount rates will the insulation generate a positive net present value (NPV)?

# Hackett example 3

Setting the problem up:

$$NPV = -\$4000/(1+r)^0 + \$1{,}000/(1+r)^1 +$$

$$\$1{,}000/(1+r)^2 + 1{,}000/(1+r)^3 +$$

$$\$1{,}000/(1+r)^4 + \$1{,}000/(1+r)^5$$

## Hackett 4

Suppose the discount rate were 0% (what does this imply about our rate of time preference?):

$$NPV = -\$4000/(1)^0 + \$1{,}000/(1)^1 +$$

$$\$1{,}000/(1)^2 + \$1{,}000/(1)^3 + \$1{,}000/(1)^4 +$$

$\$1{,}000/(1)^5 =$ \$1,000. It more than pays for itself in five years.

# Hackett 5

Suppose the discount rate were 2% (what does this imply about our rate of time preference?):

NPV = -\$4000/$(1.02)^0$ + \$1,000/$(1.02)^1$ + \$1,000/$(1.02)^2$ + \$1,000/$(1.02)^3$ + \$1,000/$(1.02)^4$ + \$1,000/$(1.02)^5$ = \$714.

It more than pays for itself in five years.

## Hackett 6

Suppose the discount rate were 5% (what does this imply about our rate of time preference?):

NPV = -\$4000/$(1.05)^0$ + \$1,000/$(1.05)^1$ + \$1,000/$(1.05)^2$ + \$1,000/$(1.05)^3$ + \$1,000/$(1.05)^4$ + \$1,000/$(1.05)^5$ = \$328.

It more than pays for itself in five years.

## Hackett 7

Suppose the discount rate were 10% (what does this imply about our rate of time preference?):

NPV = $-\$4000/(1.1)^0 + \$1{,}000/(1.1)^1 + \$1{,}000/(1.1)^2 + \$1{,}000/(1.1)^3 + \$1{,}000/(1.1)^4 + \$1{,}000/(1.1)^5 = -\$209.04$. It does not pay for itself in five years at a 10% discount rate.

## Hackett 8

Thus the higher the discount rate, the more we discount future payments, and thus the more difficult it is for environmentally friendly investments to pay for themselves over a given time horizon.

# Questions:

- Which (if any) discount rate is associated with sustainability?
- If we identify one, how would this rate relate to that we see in financial markets?

# Elements of the social rate of time preference

Opportunity cost of investment/consumption:

- Rate of growth of man-made capital stocks (opportunity cost of investment in natural resources: depends on assumption that man-made and natural capital are substitutes!) (Historically, 2-3%)
- Discounting aside (not clear from Hackett), growth in man-made capital=real income growth. This implies consumption should be shifted to the present to equate marginal utility of income over two time periods (example: student loans)

# Elements of social rate of time preference, cont.

Pure rate of time preference comes from:

- Natural propensity to consumer more now and less later
- Uncertainty regarding consumption possibilities in the future

It can be argued that the pure rate of time preference should not be included in social discount rates (especially on intergenerational equity grounds).

# Examples in use from Hackett

US Policy and Discount Rates: The U.S. Congressional Budget Office (CBO) uses a two percent real discount rate for policies having long-term social implications (Bazelon and Smetters, 1999). This two percent rate is considered to be the risk-free time preference of consumption, or the social rate of time preference. The U.S. Forest Service authorizes a four percent real discount rate for analysis of recreational resources (U.S. Forest Service, 1995, p. IV-5). Finally, the U.S. Office of Management and Budget (OMB) directs federal agencies to use a seven percent discount rate in their base-case analysis of proposed public investments (Bazelon and Smetters, 1999). The seven percent real rate is seen as the marginal pre-tax rate of return on an average investment in the private sector in recent years.

# Why might financial markets rates differ?

- Firms treat natural and man-made capital as perfect substitutes
- Firms may have short time horizons due to stockholder pressures
- Firm activities may generate uninternalized external costs, leading to artificially high rates of return on capital
- Shifting market interest rates are influenced by a variety of factors (debt levels, risk behavior)

# Pacific lumber examples (Hackett)

The old Pacific Lumber Company was largely a “family run” corporation, and forest land management was conservative (perhaps intentionally, or perhaps because they had not surveyed land holdings in years).

Hurwitz and MAXXAM realized that Pacific Lumber’s land holdings were being managed based on a discount rate far below that which prevailed in financial markets.

Thus MAXXAM could purchase Pacific Lumber at a premium (the market for corporate control), displace management, accelerate logging, and generate a rate of return closer to those that prevailed in financial markets at the time.

# Hackett example 2:

Rice et al. (1997) offer a very similar account of the economics of tropical forestry practices in Bolivia. Dollar-denominated accounts in Bolivia offered real (inflation-adjusted) annual interest rates averaging 17 percent—a decent measure of the after-inflation opportunity cost of capital. Moreover mature mahogany trees (and mahogany prices) grow slowly, and so delaying harvest for a year increases the value of the tree by only around 4 or 5 percent, much less than the 17 percent (inflation-adjusted) opportunity cost of capital. Finally, delaying harvest places the timber company at risk of policy reversal. Thus Rice and his colleagues find that the financially optimal strategy is for loggers to harvest mahogany trees as quickly as possible and invest the proceeds in financial markets to yield high returns; unrestricted mahogany harvest is two to five times as profitable as forestry practices designed to sustain the mahogany resource.

# Time consistency

- Rabin (2002): “the preference between any two intertemporal tradeoffs in momentary well-being--between, say, getting lesser satisfaction earlier vs. a greater amount of satisfaction later--is the same no matter when asked” (p. 668)
- This implies that you make one plan earlier, then will later not stick to that plan.
- Horowitz (1996) argues that shifting interest rates can lead to time-inconsistent policies

# History of exponential discounting

- Exponential discounting is equivalent to a continuous-time version of the formula presented by Hackett
- Exponential discounting was proposed as a convenient simplification
- It continues to be used because it is mathematically tractable and implies economically rational behavior
- No papers have tested exponential discounting against a time-inconsistent formulation
- Exponential discounting can't explain short-term procrastination (not consistent with observed discount rates; much too high)

# Implications of non-exponential discounting

- Long-term delays in consumption are more acceptable that short-term delays
- Plans regarding future consumption made today may not be followed in the future (the optimal choice today will no longer be optimal in the future
- Behaviors that limit future options provide evidence that people anticipate time-inconsistent decisions
- Time-inconsistent discounting can explain addiction, procrastination, and poor planning for retirement

# Short writing assignment for next week

The mortgage crisis and its effects on the broader financial markets are leading to a shortage of investment capital, which in theory is likely to lead to higher long-term interest rates. What impact are these higher rates likely to have on:

- Private decisions regarding natural resource use/investments
- Public sector investments to protect natural resources (including the biosphere)
- Public sector decisions regarding natural resource harvest rates
- If decision makers follow a time-inconsistent discounting rule, how might your above answers change?

Note: Be specific regarding your assumptions regarding what factors influence private and public discount rates. For more complex analysis, you may also incorporate political economy influences on policy making.